THE SPREAD AND INCIDENCE OF INTESTINAL PROTOZOAL INFECTIONS IN THE POPULATION OF GREAT BRITAIN

I. CIVILIANS IN LIVERPOOL ROYAL INFIRMARY
II. ARMY RECRUITS

BY

J. R. MATTHEWS, M.A.

AND

A. MALINS SMITH, M.A.

From the Liverpool School of Tropical Medicine

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INTRODUCTION

In a preliminary note (1917) we and our colleagues recorded the results of the protozoological examination of the stools of a small number of persons who had never been out of this country. The results obtained were of sufficient interest and importance to show the need for further work, and during the past year the investigation has been extended to the examination of various sections of the population. Our findings have been presented briefly by Professor Yorke (1918), but we think it worth while, in a series of short communications, to give further details of the work, and to furnish what information we have been able to obtain regarding some of the more interesting cases.

I. CIVILIANS IN LIVERPOOL ROYAL INFIRMARY

The cases examined were mainly surgical. A comparatively small number had been admitted for intestinal complaints, but no selection of the cases was made, and men, women and children were included in our examinations at random. It was possible to make only one examination of the stools, and in reviewing our results it is

important to bear this fact in mind. The results are given in the following table:—

TABLE I.

Showing percentage of cases infected with intestinal protozoa.*

	Number examined	*E. hist.*	*E. coli*	*E. nana*	*G. int.*	*C. mesnili*
Males ...	309	1·9	5·5	3·5	7·1	1·0
Females ...	141	0·7	9·2	—	3·5	2·8
Total ...	450	1·5	6·7	2·4	6·0	1·5

Trichuris trichiura eggs 1 case, *Oxyuris vermicularis* eggs 1 case, Iodine cysts 1 case.

We are not quite certain what number of cases is required to constitute a fair sample of any population, but an analysis of the results obtained at the first examination of one thousand five hundred dysentery cases examined in this laboratory indicates that at least five hundred should be examined before the findings based on a single examination may be taken as giving a reliable idea of the incidence of protozoal infections. As the two groups into which we have divided the Infirmary population are much smaller than this, the differences in the results cannot be regarded as having any significance. The main point of interest is that protozoal infections are not uncommon in the general population in Liverpool.

The following brief histories of the seven carriers of *E. histolytica* have been obtained:—

J. McK.	Age 24.	Male.	Native of Liverpool. Employed in Chemical works, St. Helens. Father a seaman.
J.J.	Age 14.	Male.	Native of Liverpool. Still at school.
J.S.	Age 54.	Male.	Native of Liverpool. Dock labourer.
D.B.	Age 10.	Male.	Never been out of Liverpool. Schoolboy. Father been in Navy for considerable number of years, recently discharged.
W.G.	Age 18.	Male.	Boiler-maker's labourer, Liverpool. Father a seaman, recently retired.
J.P.	Age 12.	Male.	Never been out of Liverpool. Schoolboy. Father a soldier who has been home once from France.
M.T.	Age 46.	Female.	Native of Liverpool. No member of family ever abroad.

* The protozoa here dealt with are *Entamoeba histolytica* (Schaudinn), *E. coli* (Lösch), *E. nana* (Wenyon and O'Connor), *Giardia* (*Lamblia*) *intestinalis* (Lambl) and *Chilomastix* (*Tetramitus*) *mesnili* (Wenyon).

While it is quite impossible to determine the source of the infection with *E. histolytica* in these seven cases, the particulars obtained convey a suggestion that in some of the infected cases the organism may originally have been introduced by relatives. The origin of *E. histolytica* infections in this country will, however, be considered later.

II. ARMY RECRUITS

Through the kindness of Capt. Glynn, R.A.M.C., facilities were obtained whereby we were enabled to make examinations of the stools of young army recruits stationed in a camp near Liverpool. This work was commenced in April, 1917. The number of recruits examined totalled one thousand and ninety-eight, each case receiving one examination. The men were examined in batches at different times of the year. The results are shown in Table II, which also gives the average length of time the recruits had been in camp before examination.

Table II.

Showing percentage of cases infected with intestinal protozoa.

	Number examined	Average length of sojourn in camp	Date of examination	*E. hist.*	*E. coli*	*E. nana*	*C. int.*	*C. mesnili*
Batch I	263	2–3 months	1917 April–May	3·0	12·1	?	4·5	—
„ II	241	2–3 months	August	6·6	23·2	6·6	7·5	1 case
„ III	230*	5 months	October	3·9	14·8	5·7	6·1	—
„ IV	98	1 month	1918 April	6·1	21·4	6·1	8·2	—
„ V	84	2·5 days	May	8·2	22·4	6·0	11·8	1 case
„ VI	104	9 days	May	5·8	17·4	12·5	6·7	—
„ VII	78	16 days	June	12·8	23·1	9·0	10·2	—
Total	1098	—	—	5·6	18·2	5·5	7·0	2 cases

Trichuris trichiura eggs 3 cases, Iodine cysts 5 cases.

* The great majority of these had been in the camp hospital for various lengths of time.

We have already stated that five hundred is probably the minimum number of cases that should be examined in order to obtain a reliable idea of the incidence of protozoal infections. We can attach no significance, therefore, to the varying percentages of infected cases among the different batches examined, as shown in the above table. The figures for the total number of cases examined are remarkably high, and it was not anticipated that protozoal infections would be found to be so prevalent among soldiers who had never been out of this country. It is not clear why a greater prevalence of infections should occur among the recruits than among the ordinary population of Liverpool as seen in the Royal Infirmary sample (see Table I). We have to consider, therefore, whether the concentration of men in camps in this country has not been a factor which may have helped in the dissemination of intestinal protozoa. There is no evidence from the figures given in Table II of any increase in the number of infected cases as the length of residence in camp increased. The results obtained from the examination of men who had been in camp a short time (see Batches V, VI and VII) indicate that they were as rich in protozoal infections as those who had remained for longer periods. It seems, therefore, that the infections were present while the men formed part of the normal civilian population of the country, and it does not appear possible to give a satisfactory explanation of the difference between the two groups, viz.: Recruits and the Infirmary population. A suggestion which we put forward in the most tentative manner is conveyed by certain facts we ascertained regarding the ages of the individuals we examined in the Infirmary. There is an indication, as shown by Table III, that infections were more prevalent among the younger members of the population. Unfortunately the question of age did not present itself to us until the investigation was well advanced, and we were able to obtain this particular for only two hundred and two men of the Royal Infirmary series. These have been divided into two groups (Table III) according to whether they were over or under 19 years of age. We chose this age because almost all the Army Recruits were under 19 years. The numbers are too small to give more than a suggestion of the facts, but it is possible that, if the Infirmary cases

had been selected so as to be of the same age as the recruits, the incidence of protozoal infections in the former would have been nearly the same as in the latter. If age is a determining factor in the way suggested, it follows that protozoal infections disappear from the intestine in the course of time. At present we have no data on this question, and direct evidence could be obtained only by prolonged examinations of known infected cases. We shall return to the matter in a later paper in discussing the work done among children.

The general conclusion reached from the present work is that intestinal protozoal infections are by no means uncommon in the population of these islands. In the absence of further facts, it will serve no useful purpose to discuss in detail the probable origin of these infections. The protozoa concerned may have occurred

Table III.

Showing the number of cases infected among 202 men grouped according to age.

Over 19 years of age		Under 19 years of age	
Number examined...	164	Number examined	38
E. histolytica	2 cases	*E. histolytica*	4 cases
E. coli	10 ,,	*E. coli*	5 ,,
G. int.	8 ,,	*G. int.*	10 ,,

among persons in this country for a very long time, i.e. they may be regarded as indigenous, or they may have been recently introduced by the large number of returned soldiers, many of whom were carriers of *E. histolytica* and other protozoa. But apart from the return of infected soldiers during this and previous wars, another source of infection exists in the constant arrival of seafaring people, many of them no doubt from tropical and sub-tropical regions. This source of infection has existed for centuries, and would be sufficient in the course of time (presuming the primary origin of the infections to be tropical) to result in a general distribution of the organisms throughout the population. In this connection, we may mention that of four hundred and fifty non-dysenteric naval and military patients examined by us in a previous investigation, eighty-two

were sailors, of whom five were found to be carriers of *E. histolytica*, ten were infected with *E. coli*, ten with *G. intestinalis*, and one with *C. mesnili*. It is now practically impossible to obtain any reliable idea of the incidence of protozoal infections in the population of this country before the war, and in consequence we cannot estimate the effect of the return of large numbers of carriers.

Some of the results we have obtained seem to indicate that there may be occupational differences in the incidence of infection. The seventy-eight men comprising Batch 7 (Table II) were miners, and it will be seen that the percentage of infected cases among them was high. Although the number is small, the results suggest a further line of enquiry.

Particulars of the sixty-two recruits infected with *E. histolytica* are given in Table IV. The particulars give some idea of the distribution of the parasite, and they show also that it is found among persons of various occupations.

TABLE IV.

Particulars relating to carriers of *Entamoeba histolytica* among Army Recruits who have never been out of Great Britain.

No. of Case	Age, in years	Place of Residence	Civil Occupation	Date of joining Army and going to training camp	Date of examination
1	18	Manchester	Clerk	Mar. 12, 1917	April 19, 1917
2	18	Ashton-under-Lyne	Spinner ...	Mar. 7, 1917	April 19, 1917
3	18	Chorley	Bleaching Works Employee	Mar. 14, 1917	April 19, 1917
4	18	Manchester	Carter	Mar. 7, 1917	May 10, 1917
5	18	Liverpool	Dock Labourer	Mar. 12, 1917	May 10, 1917
6	19	Wigan	Carter	Mar. 5, 1917	May 10, 1917
7	18	Burnley	Shop Assistant	Mar. 12, 1917	May 10, 1917
8	18	Manchester	Packer	Mar. 12, 1917	May 10, 1917
9	18	Manchester	Warehouseman...	July 18, 1917	Aug. 8, 1917
10	—	—	—	—	Aug. 8, 1917

TABLE IV—*continued*.

No. of Case	Age, in years	Place of Residence	Civil Occupation	Date of joining Army and going to training camp	Date of examination
11	18	Aberdare	Clerk	July 10, 1917	Aug. 8. 1917
12	19	Carmarthen	Spinner ...	July, 1917	Aug. 8, 1917
13	18	Ellesmere	Butcher ...	July, 1917	Aug. 8, 1917
14	18	Birkenhead	Clerk	July 19, 1917	Aug. 8, 1917
15	18	Salop	Farm Labourer	June 11, 1917	Aug. 28, 1917
16	18	Leeds...	Farm Labourer	June 12, 1917	Aug. 28, 1917
17	19	Abergavenny ...	Engine Cleaner	June 7, 1917	Aug. 28, 1917
18	18	Stratford	Motor Mechanic	May, 1917	Aug. 28, 1917
19	18	Blackpool	Chemist ...	April 4, 1917	Aug. 28, 1917
20	18	Nr. Oswestry ...	Miller	May 16, 1917	Aug. 28, 1917
21	18	Swansea	Steel Worker ...	April, 1917	Aug. 28, 1917
22	18	South Wales ...	Collier	July 1, 1917	Aug. 28, 1917
23	18	Abersychan	Carter	July 1, 1917	Aug. 28, 1917
24	18	Bootle	Blacksmith ...	April, 1917	Aug. 28, 1917
25	18	Liverpool	Grocer	Aug. 2, 1917	Oct. 5, 1917
26	18	Nr. Preston	Greengrocer and Cabdriver	July 10, 1917	Oct. 4, 1917
27	18	Aberystwyth... ...	Engine Cleaner	July 11, 1917	Oct. 6, 1917
28	18	Rhondda, South Wales	Miner	Aug. 14, 1917	Oct. 17, 1917
29	18	Liverpool	Shipyard Labourer	July 10, 1917	Oct. 16, 1917
30	18	Rhondda Valley ...	Miner	Jan. 1917	Oct. 18, 1917
31	18	Llanelly	Fitter's Mate ...	Sept. 5, 1917	Oct. 31, 1917
32	18	Dowlais, South Wales	Electrician ...	June 13, 1917	Oct. 30, 1917
33	18	St. Albans	Vanman and Grocer's Assistant	Sept. 17, 1917	Oct. 10, 1917
34	18	Bethesda	Slate Quarryman	Mar. 3, 1918	April 10, 1918
35	18	St. Helens	Glass Works Labourer	Feb. 15, 1918	April 10, 1918
36	18	Kirkby Lonsdale ...	Joiner	Mar. 24, 1918	April 10, 1918
37	18	Treherbert, South Wales	Collier	Mar. 13, 1918	April 10, 1918

TABLE IV—*continued.*

No. of Case	Age, in years	Place of Residence	Civil Occupation	Date of joining Army and going to training camp	Date of examination
38	18	Cardiff	Collier	Feb. 2, 1918	April 10, 1918
39	18	Oldham	Railway Clerk ...	Mar. 3, 1918	April 10, 1918
40	18	Carlisle	Cotton Spinner	May 4, 1918	May 7, 1918
41	18	Earlestown	Glass Worker ...	May 2, 1918	May 7, 1918
42	18	Wigan	Collier	May 6, 1918	May 7, 1918
43	17	Tonyrefail, South Wales	Collier	May 3, 1918	May 7, 1918
44	18	Bolton	Textile Fitter ...	May 4, 1918	May 7, 1918
45	18	Liverpool	Carter	May 6, 1918	May 7, 1918
46	18	Liverpool	Dock Porter ...	May 4, 1918	May 7, 1918
47	18	Liverpool	Labourer ...	May 13, 1918	May 22, 1918
48	18	Blackburn	Weaver	May 11, 1918	May 22, 1918
49	18	Carlisle	Engine Cleaner	May 4, 1918	May 22, 1918
50	18	Liverpool	Machinist ...	May 9, 1918	May 22, 1918
51	18	Cleator Moor ...	Clerk	May 9, 1918	May 22, 1918
52	18	Wigan	Baker	May 9, 1918	May 22, 1918
53	19	Caerau, South Wales	Collier	May 25, 1918	June 11, 1918
54	26	Tonyrefail, ... South Wales	Collier	May 24, 1918	June 11, 1918
55	24	Carmarthen ...	Collier	May 26, 1918	June 11, 1918
56	22	Pontypool, South Wales	Collier	May 25, 1918	June 11, 1918
57	25	Pontypool, South Wales	Collier	May 24, 1918	June 11, 1918
58	21	Tonyrefail, South Wales	Collier	May 26, 1918	June 11, 1918
59	23	Pontypool, South Wales	Collier	May 23, 1918	June 11, 1918
60	23	Abertysswg ...	Collier	May 23, 1918	June 11, 1918
61	27	Pontllanfraith, South Wales	Collier	May 26, 1918	June 11, 1918
62	—	Brynamman, South Wales	Collier	May 29, 1918	June 11, 1918

We give, finally, in Table V a comparison of our results with those obtained by ourselves and others from the examination of soldiers who have been abroad.

Table V.

Showing percentage of cases infected with intestinal protozoa.

	Recruits never out of Great Britain (Table II above)	Healthy troops in Alexandria (Wenyon and O'Connor)	Dysenteric convalescents (Mackinnon)	Non-dysenteric convalescents (Mackinnon)	Dysenteric convalescents (Liverpool)	Non-dysenteric convalescents (Liverpool)
Number examined	1098	1979	914	766	1713	450
E. hist. ...	5·6	5·3	4·9	3·5	5·9	6·4
E. coli ...	18·2	20·0	...	...	15·5	14·2
E. nana ...	5·5	0·5	...	...	...	...
G. int. ...	7·0	4·8	...	...	11·3	10·8
C. mesnili	2 cases	1·1	...	...	...	...

All the findings recorded in Table V are based on a single examination per case, and the remarkable fact appears that protozoal infections are as prevalent among soldiers who have never been out of this country as among troops in Egypt and those who have been invalided home from various fronts. It therefore becomes impossible to say whether the men examined in Egypt actually became infected before or after they left this country. Wenyon and O'Connor found that 13·5 per cent. of five hundred and twenty-four healthy natives in prison in Alexandria were infected with *E. histolytica*, and concluded 'that the native of Egypt is acting as a reservoir of infection for the intestinal protozoa with which the British troops have become and are becoming infected.' In view of this statement, the results we have obtained are of considerable interest.

There is apparently, however, one marked difference between persons infected with *E. histolytica* at home and abroad. A considerable percentage of those abroad become victims of acute amoebic dysentery, while at home the number of such cases is comparatively

small. We agree with Wenyon and O'Connor in thinking that the danger of amoebic dysentery becoming widespread in England is remote. While they base their conclusion largely on the belief that the conditions necessary for the spread of cysts of *E. histolytica* do not exist in any marked degree, we would remark that the evidence produced in the present investigation points to the common occurrence of the organism in persons in this country. If amoebic dysentery does not occur commonly it is not because *E. histolytica* is rare. The reason is probably to be found in a combination of factors which are now becoming recognised and need not be discussed here.*

In conclusion, we wish to express our gratitude to Professor W. Yorke for the interest he has always taken in the progress of this investigation. We wish to mention, also, that in the earlier part of the investigation some of the examinations were made by our former colleagues Mr. H. F. Carter and Dr. D. L. Mackinnon, to whom we tender our thanks. We are much indebted to the military authorities at Kinmel Camp for giving us facilities for carrying out our work among recruits, and we take this opportunity of expressing our thanks to them. Thanks are also due to Sergeant Fann who, by kind permission of Captain Glynn, rendered invaluable help in the collection of the specimens from recruits.

SUMMARY

Among four hundred and fifty civilians (men, women and children) in Liverpool Royal Infirmary, seven, or 1·5 per cent., were found by one examination per case to be carriers of *Entamoeba histolytica*.

Among one thousand and ninety-eight healthy young recruits, one examination revealed sixty-two, or 5·6 per cent., to be infected with *E. histolytica*.

Reasons have been given for thinking that the numerical differences between the results for the two groups are probably not significant. Whereas the young recruits form a specially selected

* See Wenyon and O'Connor (1917), and Dobell's review of their work (1918).

section of the population, the Infirmary cases constitute a very mixed population.

The non-pathogenic intestinal protozoa (*E. coli*, *E. nana*, *Giardia* and *Chilomastix*) are commonly distributed in the population of this country.

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